Adaptive, multi-level learning in flood risk management: A case study of organizational learning through stakeholder involvement

Alan Diduck
Department of Environmental Studies & Sciences
The University of Winnipeg
Email: a.diduck@uwinnipeg.ca
Ph: +1 (204) 786-9777

Abstract

Flood risk management typically involves multiple objectives and stakeholders, uncertainty and indeterminacy, disputes over values, norms and knowledge claims, and the need for innovation. In such a context, participatory management has important advantages over programmed, rational comprehensive approaches. One advantage is that it furnishes opportunities for adaptive, multi-level learning, i.e., learning based on management experiences at and across multiple societal levels. Such learning can help management actors gain insight into the intricacies and dynamics of flood prone systems, develop shared understandings of emerging risks and potential solutions, make decisions under conditions of high uncertainty, and guide flood policy development along sustainable trajectories. This paper outlines a conceptual framework of adaptive, multi-level learning by people, action groups, organizations, networks, and societies, and presents a retrospective case study of organizational learning through stakeholder involvement in five government-led flood risk management initiatives. The framework was developed using an integrative literature review that synthesized learning constructs from various disciplines, and the case study was crafted using semi-structured interviews and an extensive review of organizational records. The geographic setting of the case is the Red River Basin, Canada. The results reveal that the management initiatives afforded promising platforms for single-loop, organizational learning, such as enhanced technical knowledge. They also illustrate that the initiatives were limited in enabling double-loop learning for the subject organization, whose fundamental governing variables were forged in opposition to government policy and action. Last, the conceptual framework and case study highlight the promise of, and opportunities for research into, double-loop learning for sustainable flood management.

Key words

stakeholder involvement; public participation; flood risk management; adaptive, multi-level learning; organizational learning; single- and double- loop learning; Red River Basin, Canada

1. Introduction

Participatory management has received significant attention in recent years for various reasons, including the fact that its learning implications are seen as important for dealing with complex resource and environmental problems (Folke et al. 2005, Evely et al. 2011). Moreover, there has been a growing recognition that the most serious resource and environmental issues are just such problems. They are embedded in dynamic, multi-scale, social-ecological systems, and fraught with normative, behavioural and interest conflict (Gunderson and Holling 2001, Berkes et al. 2003). This is true not only of complicated resource development and environmental protection issues, but also of risk and hazards issues, including flood risk management (Butler and Pidgeon 2011, Heintz et al. 2012).

Flood risk management, at least at larger scales in more developed regions, typically comprises a range of structural and nonstructural adjustments (de Löe 2000, Green 2010). This mix of management initiatives usually involves multiple and discordant objectives and stakeholders with diverse and incompatible interests and values (Mitchell 2005, Tseng and Penning-Rowsell 2012). In addition, it typically involves not only risk but also higher levels of uncertainty, such as indeterminacy (Wynne 1992). As a result, flood risk management often requires high levels of adaptive capacity to deal with turbulent environments (Armitage and Plummer 2010, Newig and Koontz 2014).

In this context, participatory flood risk management offers significant advantages relative to the top-down, rational comprehensive models evident in the security paradigm of flood protection (Heintz et al. 2012, Newig et al. 2014). One advantage is that it furnishes opportunities for adaptive, multi-level learning, i.e., learning based on management experiences at and across multiple societal levels, e.g., people, groups, organizations and networks (Pahl Wostl 2009, Diduck 2010). Such learning can help the full array of management actors gain insight into the intricacies and dynamics of flood prone systems, develop shared understandings of emerging risks and potential solutions, make decisions under conditions of high uncertainty, and guide flood policy development along sustainable trajectories. It can also help resolve normative, behavioural and interest conflict, which is integral to the deep-seated learning outcomes necessary for diverting from entrenched, unsustainable management strategies and practices.

This paper contributes to the growing literature on participatory flood risk management. After summarizing the research materials and methods, I outline a conceptual framework of adaptive, multi-level learning, and present a retrospective case study of organizational learning through stakeholder involvement in flood risk management in the Red River Basin, Canada. In the final section I review the implications of the framework and the case study for flood risk management.

2. Materials and methods

The conceptual framework was developed through an integrative literature review (Torraco 2005), the purpose of which was to explicate learning processes and outcomes at various societal levels, along with interconnections among those levels. The review selectively synthesized leading constructs from various disciplines, including adult education and learning, organization and management studies, political studies and foreign policy analysis, resource management, and environmental planning (Diduck 2010).

The case study is qualitative and constructivist (Creswell 2014). The subject is a community-based organization that was involved in flood risk management in the Red River

Basin, Canada, and the object is organizational learning that occurred as a result of the involvement (Thomas 2011). Organizational learning was chosen as the object because it is an essential link between the foundation of adaptive, multi-level learning, i.e., learning by people and action groups, and learning at higher levels, where changes to societal conventions, norms and formally sanctioned rules are made possible. The case study describes the subject's learning experiences and in doing so illuminates aspects of the conceptual framework (Flyvbjerg 2006). The study involves a single retrospective case with nested elements (Thomas 2011), namely the subject's learning experiences associated with five government-led management initiatives occurring from 1997 to 2005.

Semi-structured interviews were held with five of the community organization's leaders (four men, one woman; eight interviews in total). The interviews, which lasted between 60 and 90 minutes, were audio recorded and transcribed. Data collection also involved reviewing nearly 400 documents, including correspondence, meeting minutes, annual reports, impact assessment reports, technical studies, court records, written testimony, press releases and newspaper stories. Analysis relied on QSR's NVivo qualitative data analysis software, and involved coding and grouping data segments based on the organizational learning component of the conceptual framework (Creswell 2014). To ensure trustworthiness, results were validated by triangulation and through participant checks in which research participants were asked to review and verify their interview transcripts. To help protect confidentiality, the case study is presented as a general narrative and the identities of the organization and interview participants are not revealed.

3. Conceptual framework

Learning has been a topic of research in resource and environmental management for decades (Korten 1980), and the literature reveals important insights into: how individuals and social collectives learn (Röling 2002, Rist et al. 2007); how to design resource management functions that enable learning (Webler et al. 1995, Keen et al. 2005); and, what individuals and collectives learn because of their participation (Bouwen and Taillieu 2004, Diduck et al. 2012). The literature also discusses ongoing research opportunities: increased precision in defining learning and explaining who or what is doing the learning (Armitage et al. 2008); more attention to learning at different societal levels (Pelling et al. 2008); and, new concepts, methods and metrics for conceptualizing and measuring learning (Crona and Parker 2012). The framework presented below, which builds on Diduck (2010), was spurred by these opportunities.

3.1. Adaptive, multi-level learning

Adaptive, multi-level learning is conceived of as learning at and across multiple societal levels based on feedback from resource management experiences. Fig.1 situates such learning in the context of flood risk management undertaken in response to vulnerabilities, hazards or disasters. For simplicity's sake, the paper emphasizes just selected conceptualizations of learning and associated societal levels, and hence the figure distinguishes among individual, social, organizational, network and societal learning. However, it is important to recognize that there are other conceptions and levels with significant explanatory power and probative value, e.g., policy learning (Haas 2002), communities of practice (Wenger 1998) and informal organizations (Pelling et al. 2008).
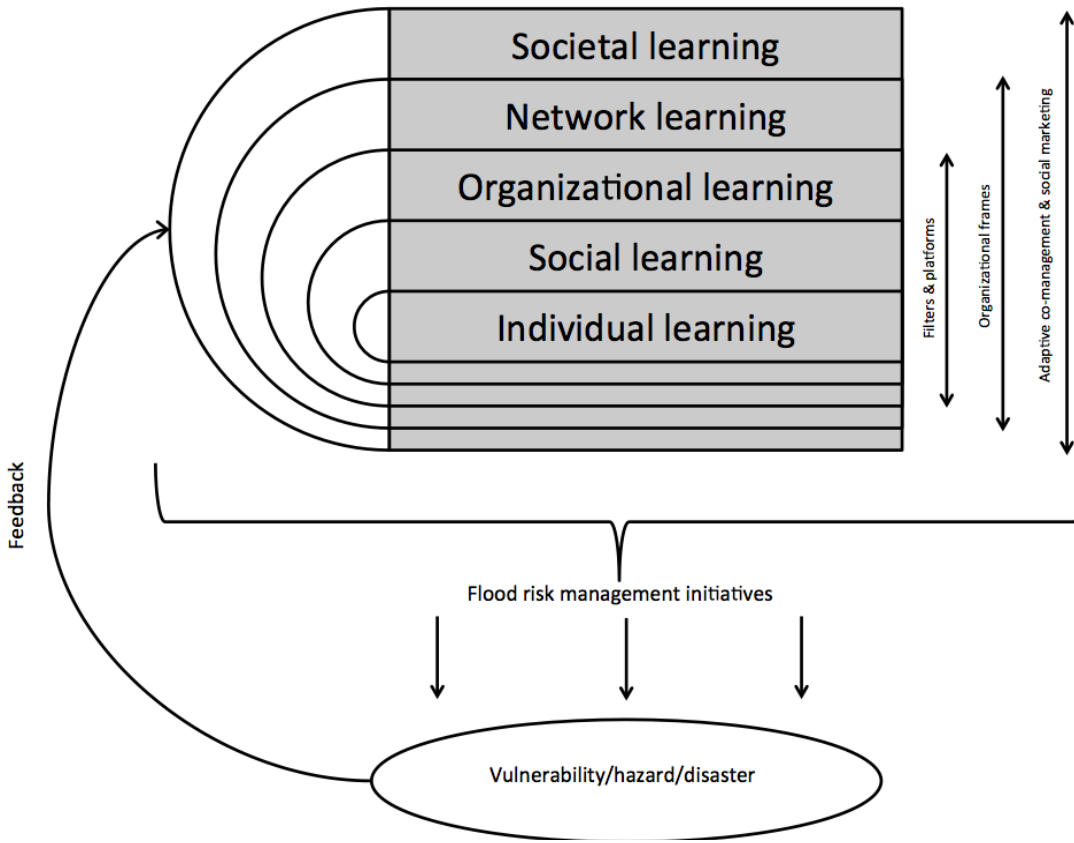
Fig 1. A framework of adaptive, multi-level learning in the context of flood risk management.

Table 1 describes features for each of the selected conceptualizations of learning along with descriptions of the pertinent societal levels. Examples of learning outcomes at these various levels are not hard to imagine in the context of flood risk management. For instance, individual and social learning would be manifest if, after attending a flood risk management workshop, people with seemingly divergent interests, such as a farmer intent on draining wetlands for economic reasons, an environmentalist dedicated to conserving wetlands to protect ecological values, and an engineer mandated to pursue a system of dikes and detention basins, gained insights into each other's views and discovered a shared interest in climate change adaptation.

Although Fig. 1 and Table 1 might suggest clear distinctions among the societal levels, it is important to note that in reality some distinctions are fuzzy and can be difficult to recognize in any particular instance of multi-level learning, such as differences in formal structure between an action group and an organization. As well, the levels are interconnected in the sense that learning outcomes at one level can influence outcomes at other levels. These interactions are depicted in the figure by the bi-directional vertical arrows in the upper right quadrant. Table 2 summarizes five selected sets of such interactions: socio-cognitive filters, facilitated platforms, organizational frames, adaptive co-management arrangements, and community-based social marketing. Again, the table and the figure might imply a neat, nested hierarchy with clear interconnections, but in reality the interplay across the societal levels is often messy, or highly complicated.

3

Table 1. Selected conceptualizations of learning and associated societal levels

Conceptions of Learning	Related Societal Levels
Individual learning: the process by which a person's knowledge, skills, beliefs, or behaviours are changed as a result of experience (Merriam et al. 2007)	Individual: the discussion in this paper applies most directly to adults rather than children (Mezirow 2000)
Social learning: the processes by which individual learning outcomes become distributed and mutual outcomes in a collection of individuals (Röling 2002)	Action group: a cohesive but relatively informal association of people focused on specific objectives and tasks, often with a short lifespan (Friedmann 1987)
Organizational learning: the processes by which individual or social learning outcomes are stored in and withdrawn from organizational memory (Argyris and Schön 1978, Argyris 1990)	Organization: like an action group but often with a longer lifespan and more complex mandate, and usually framed by formal membership and rules
Network learning: the processes by which organizational learning outcomes become distributed and mutual outcomes in a collection of organizations and thus change network-level properties (Knight and Pye 2004, 2005)	Organizational network: a collection of organizations lacking an overarching structure but sharing political, social, economic or cultural interests
Societal learning: the democratic processes by which core societal institutions are changed in response to social and environmental change (Woodhill 2002, Waddell 2005)	Society: the community of people in a particular region or country with shared customs, organizations, and laws

Table 2. Selected linkages among learning outcomes at different societal levels

Social-cognitive filters: Psychological and social mediators of individual, social and organizational learning, e.g., peer engagement (Andrews and Delahaye 2000)
Facilitated platforms: Deliberate interventions in which interdependent stakeholders are brought together to interact in a forum for collective decision making towards concerted action (Maarleveld and Dangbégnon 1999)
Organizational frames: Cultural and structural arrangements that enable individual and social learning within an organization as well as the development and use of organizational memory (Bapuji and Crossan 2004)
Adaptive co-management arrangements: Community-based systems of resource management tailored to specific places and situations; supported by and working with various groups and organizations at different scales (Armitage et al. 2009)
Community-based social marketing: Principles, strategies and practices for influencing human behavior to achieve public goals, emphasizing involvement of the people whose behaviour is targeted (McKenzie-Mohr and Smith 1999)

3.2. Organizational learning

This section digs deeper into one aspect of the conceptual framework, namely organizational learning, and in doing so sets the stage for the case study. I have adopted the theory of action framework (Argyris and Schön 1978, Argyris 1990) because it sheds light on learning processes and outcomes, explains connections between individual and organizational learning, offers simple yet powerful heuristic concepts, and is adaptive in orientation. In the theory of action, learning is experiential and involves detecting and correcting errors, defined as gaps between intended and actual outcomes of action (Fig. 2). Single-loop learning occurs when mismatches are corrected by changing instrumental strategies, purposes and actions. That is, single-loop learning is focused primarily on effectiveness, or fulfilling existing purposes in the context of a given set of fundamental governing variables, i.e., basic presuppositions, norms and values. "Single-loop learning can be compared with a thermostat that learns when it is too hot or too cold and then turns the heat on or off" (Argyris 1977, 116).

Double-loop learning is more normative in nature, involving the correction of mismatches between intentions and outcomes by evaluating and changing both instrumental means and ends and fundamental governing variables. "If the thermostat could question itself about whether it should be set at 68 degrees, it would be capable not only of detecting error but of questioning the underlying policies and goals of its own program" (Argyris 1977, 116). Given this normative orientation, double-loop learning often involves resolution of conflict over basic values and aspirations.

Learning in organizations occurs at both individual and collective levels, i.e., by action groups and by the organizations themselves. Since individuals and action groups are the agents for organizations, learning at those levels is a necessary condition for organizational learning. However, learning at the organizational level does not occur until individuals or groups embed what they have learned in organizational memory, consisting of private images, i.e., mental models of self in relation to others and in relation to the organization, and public maps, e.g., rules, by-laws, licenses, management plans. Further, organizational learning requires action, actualized by individuals and groups as agents, founded on organizational memory. For example, organizational learning would be observed if, after consulting with stakeholders and conducting hydrological studies, scientists and managers in a flood risk management agency incorporated what they learned into a new or enhanced catchment management plan, with the plan subsequently being adopted and acted upon by the agency. The resulting action could then, of course, yield new individual and social learning outcomes that become embedded in the agency's memory, thus renewing the organizational learning cycle (Argyris and Schön 1978, Argyris 1990).
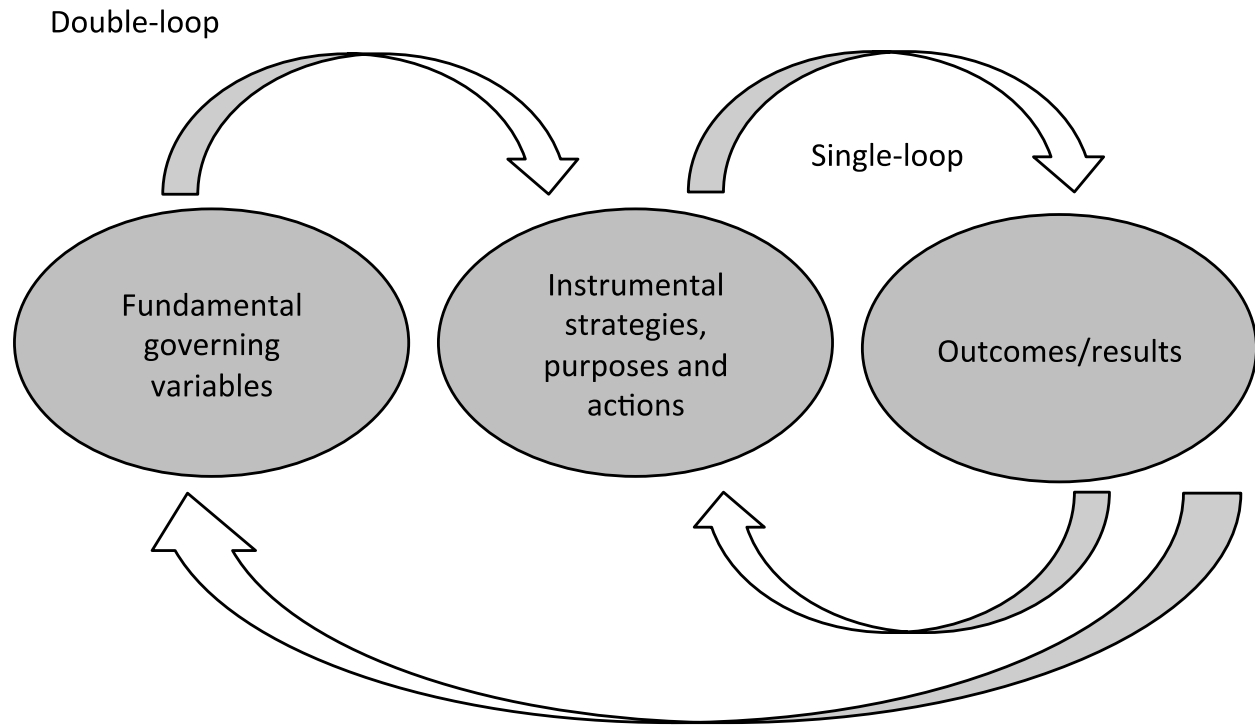
Fig. 2. Single- and double-loop learning (Argyris and Schön 1978, Argyris 1990).

4. Case study
4.1. Flooding in the Red River Basin

      The Red River originates in Minnesota and flows north to Lake Winnipeg (Fig. 3). The river basin includes northwestern Minnesota, eastern North Dakota, southern Manitoba, and a small portion of South Dakota. The largest urban centre in the basin is Winnipeg, Manitoba, with a population of 663,617 in 2011 (Statistics Canada 2012). The basin is wide and flat, with an elevation change of only 70 m over a distance of 877-river km, and an average slope of 0.1 m/km. At its widest point, the valley spans 100 km. This topography contributes to flooding conditions as floodwaters can spread over a large area. Flooding conditions are further increased by the valley's clay soils, which have low absorptive capacity. Major flooding usually occurs after several wet years. Heavy precipitation during the preceding summer and fall saturates the ground and fills the natural water storage sites. A hard, deep frost prior to the first snowfall impedes absorption of water during spring run-off. A cold winter with abundant snowfall and minimal thawing provides a heavy snow pack, which is released within a short period if there is a late and sudden spring thaw. These conditions can be exacerbated by heavy rain or wet snow during the break-up, and by southern winds, which cause wave action and raise the peaks in the northern flooding zone. The northward flow of the water further contributes to flooding through the south-to-north progression of melting and the potential for ice jams to cause backups and overflow, particularly where the river enters Lake Winnipeg (International Joint Commission 2000, St. George and Rannie 2003).

Fig. 3. The Red River Basin, including selected communities and flood protection works (Diduck et al. 2005).

Radiocarbon dating of sediment deposits and tree ring analysis provide evidence of flood events in the Red River Basin for over a thousand years. Aboriginal oral histories have described major flood episodes in 1776, 1790 and 1809. The largest flood on record, in 1826, had a peak flow of an estimated 6,370 m^3/s at the junction of the Red and Assiniboine Rivers in Winnipeg. Other significant flood events occurred in 1852 (3,823 m^3/s) and 1950 (3,042 m^3/s). Following the 1950 flood, both structural and non-structural flood management measures were adopted in the basin. In Canada, the structural measures included dikes in Winnipeg and around several rural communities. As well, three major control structures were built: the Shellmouth Dam (a storage reservoir on the western Assiniboine River); the Portage Diversion (a channel from the Assiniboine River to Lake Manitoba); and, the Red River Floodway (a 48-km long channel that diverts flood waters around Winnipeg, offering protection from 1-in-90 year floods) (Fig. 4). With respect to non-structural measures, various programs were implemented, including the Flood

Damages Reduction Program, the Disaster Assistance Plan, and the Manitoba Flood Forecasting Committee (Bumsted 1997, International Joint Commission 2000, St. George and Rannie 2003).
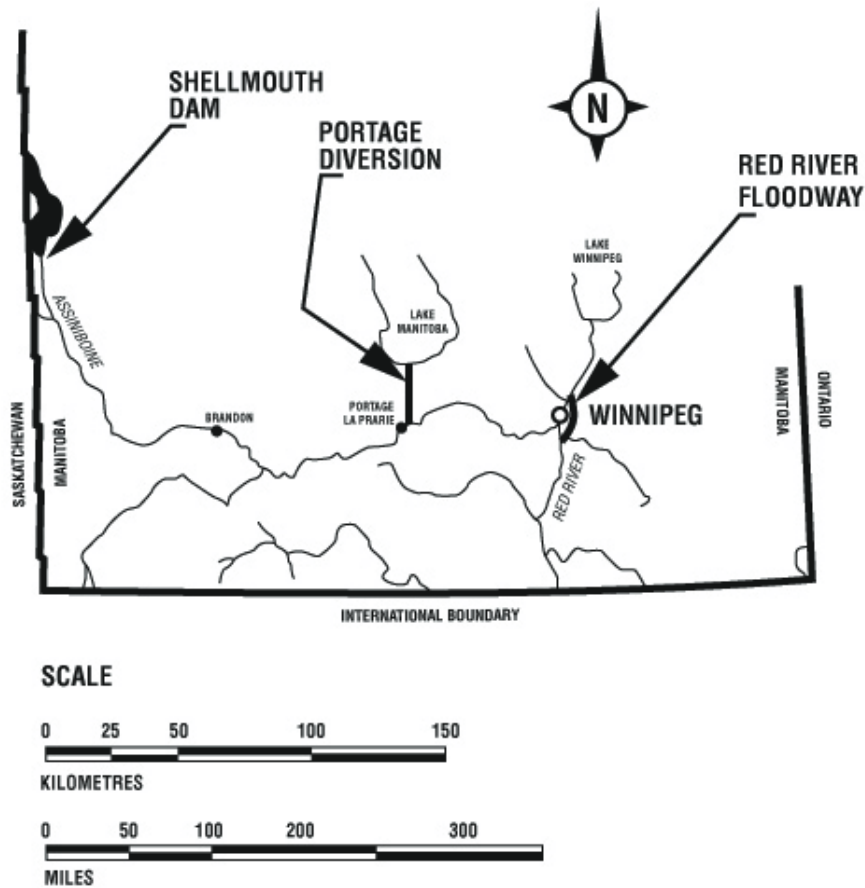

Fig 4. Three major flood control structures in Manitoba (Manitoba Clean Environment Commission 2005).

4.2. The 1997 flood

A major flood occurred in 1997 with peak flows of 4,590 m^3/s at the junction of the Red and Assiniboine Rivers. Key factors contributing to the magnitude of the flood were high autumn soil moisture content, near-record levels of winter precipitation, and a severe storm in early April that left up to 48 cm of snow in some parts of the basin. The largest flood since 1826, the 1997 event seriously tested flood protection measures (structural and non-structural) in both the United States and Canada. Generally, Manitoba's flood protection and response mechanisms proved adequate. The control structures around southern Manitoba towns and the City of Winnipeg all held, although some were just barely sufficient and many communities and homes outside these structures suffered severely. For example,

Ste. Agathe, Manitoba, 24 km south of Winnipeg in the Municipality of Ritchot (Fig. 3), was devastated when overland flooding breached temporary dikes (International Joint Commission 2000, Shrubsole et al. 2000).

4.3. The organization's baseline values, goals, and strategies
    In the aftermath of the 1997 flood, groups of residents in the Red River Basin – both upstream and downstream of Winnipeg – formed organizations to advance their interests in upcoming flood risk management initiatives. One of these groups is the case study subject (CBO), a relatively informal and unstructured organization whose leadership included exurbanites working in Winnipeg. When recalling the CBO's formation and how it established its mandate, one of the leaders said, "We looked at these objectives from the organizing committee and we basically asked what should we be out there doing, and those were the points that we picked up on from the community and went forward with" (Participant 1).
    Public maps in organizational memory revealed the CBO's baseline values, goals and strategies (sources: founding meeting minutes, community meeting minutes, strategy document, correspondence). The CBO's position was that actions taken to protect Winnipeg worsened flood impacts beyond the city's borders. These actions were the routine operation of the floodway gates, operation of the gates in contravention of the established rules, and cutting roads to re-direct the flow of flood waters. The CBO acknowledged that the purpose of these actions, to save Winnipeg, was appropriate, however the organization believed the government did not adequately acknowledge the adverse effects in surrounding areas. The Manitoba government defended its actions on the basis of a cost/benefit analysis, stating that its actions minimized overall economic losses.
    The CBO argued that since surrounding areas were impacted by actions to prevent flooding in Winnipeg, losses resulting from these actions should be fully compensated. The CBO's primary initial strategy was to muster evidence of its position, and to use that information to persuade the government to provide appropriate compensation. Second, the CBO, like many stakeholders in the Red River Basin, believed that a comprehensive basin-wide strategy should be developed that would take into account floodway operation, emergency plans and operations, and compensation.
    Generally, the CBO relied on administrative and management remedies to achieve its purposes. The organization's initial strategy was to organize its members, commission an independent analysis of the impacts of the floodway, and make presentations to government officials.

4.4. Manitoba Water Commission hearings
    In pursuing its mandate, the CBO prepared for and participated in hearings convened by the Manitoba Water Commission (sources: briefing note, community meeting minutes, correspondence, newspaper reports, technical report, written testimony). In doing so, the organization acquired substantial knowledge of the technical aspects of floods and flood protection measures, which was incorporated into its public maps and used to actualize its intentions. Participation in the hearings yielded several positive outcomes in terms of the organization's baseline values and goals, i.e., the CBO experienced important matches between its intentions and the outcomes of its actions. Its independent flood analysis

spurred the commission to order its own study, which ultimately confirmed the CBO's position, and the government subsequently pledged to compensate affected landowners.

However, the government did not officially recognize that the floodway was operated inappropriately, the compensation was not what the CBO considered full and equitable, and the organization believed that a basin-wide comprehensive flood management strategy was not forthcoming. As one member put it, "They don't want to look at the strong adverse effects to the environment. They have a 600,000 population to protect, and so that far outweighs any adverse effect to the environment or to people within that environment" (Participant 2). Therefore, the successes identified above, i.e., the matching intentions and outcomes, were seen by the CBO as only partial victories. As well, it still remained to be seen if government would act on the recommendations of the water commission, and the CBO was not overly hopeful in this regard.

4.5. Dike proposal

In December 1997, the CBO became involved in opposing a government proposal to construct a dike along a provincial road in order to add further flood protection for Winnipeg (sources: briefing note, correspondence, impact assessment report, meeting minutes, technical report). The organization was opposed to the project because it believed the dike would worsen flooding in areas outside of Winnipeg. Over the following months, the organization applied for and received access to government information under *The Freedom of Information and Protection of Privacy Act*, wrote letters to its members and the provincial government, participated on the provincial steering committee for ring dikes, and initiated a letter writing campaign – all in protest of the dike proposal.

The CBO advocated for an integrated mix of smaller flood protection structures, environmental and cost/benefit analyses and public hearings for all new structures, and a basin-wide flood management plan. The organization viewed as unsatisfactory the government's initial response to these issues, and therefore engaged in further rounds of lobbying. Eventually, a municipality outside of Winnipeg joined in opposition to the project, and a federal government agency withdrew its financial support until the dike's full effects were determined.

For the CBO, blocking the dike proposal was a success, and in this regard represented a match between intended actions and outcomes. This experience confirmed for the CBO the appropriateness of its objectives, strategies and actions, and confirmed the validity of its fundamental governing variables. It also led to strengthened relationships with other organizations and enhanced technical knowledge of floods, both of which were manifested in the CBO's public maps and actions.

4.6. Red River Floodway rules of operation review

In December 1998, the provincial government struck a committee to review the floodway rules of operation, and the CBO sought to be involved (sources: access to information records, briefing note, court records, correspondence, meeting minutes). The organization asked to sit on the committee, but the government denied the request. The CBO then sought other ways to affect the review process. It worked with a local municipal government representative who had been appointed to the committee. It requested access to government information, wrote to and met with government and elected officials, met with members of the review committee, and commented on the final report. Further, after

the federal environment ministry approved the revised rules in April 2001, the CBO sought a judicial review of the ministry's decision.

The CBO's objectives in the rules review process were consistent with its original mandate. Among the specific issues it raised were that floodway operation worsened flooding outside of Winnipeg, the proposed changes to the rules would make things worse, and the final report did not consider compensation. Ultimately, the organization saw some successes in the review process, e.g., it was granted access to government information, but in its view its substantive concerns and suggestions went largely unheeded. Moreover, in February 2002 its federal court action was dismissed.

The CBO's lack of success in the rules review process reflected mismatches between intentions and outcomes, and single-loop learning can be seen in the adoption of a new tactic – the legal action – representing a more adversarial method than had been used in the past. In addition, the CBO's public maps reflected enhanced knowledge of flooding, hydrology, engineering, and legal procedures. Overall, however, there was no evidence of double-loop learning, i.e., changes to the organization's fundamental governing variables.

4.7. Flood protection studies

Following the 1997 flood, the International Joint Commission investigated flooding in the Red River Basin and ways to prevent and mitigate future flood losses. The commission created a multidisciplinary task force, which conducted pre-feasibility studies of expanding the floodway and constructing a detention basin near Ste. Agathe. To obtain public input on the task force's December 1997 interim report, the commission held a series of public meetings. Ultimately, the commission's final report recommended that Manitoba either expand the floodway or build the Ste. Agathe project (International Joint Commission 2000).

Shortly after release of the report, the Manitoba government retained the KGS Group to expand on the pre-feasibility studies (Sinclair et al. 2003). The new study included environmental, engineering, socio-economic and cost/benefit aspects. Public involvement during preparation of the KGS report consisted of 26 key informant interviews. Within a month of the release of the report, the Manitoba government announced a series of public meetings regarding the two options. In February 2002, the government released its final report, with the government opting for the floodway expansion.

The CBO participated in these studies and meetings by presenting at the International Joint Commission meetings, participating in two KGS interviews, and presenting at two government-led meetings (sources: correspondence, meeting notes, written testimony). As in the earlier management initiatives, the CBO's objectives were consistent with its original mandate. Again, it highlighted operation of the floodway and lack of a basin-wide approach. With respect to the KGS study, the CBO argued that the scope was too narrow, it failed to address operational questions, and it was inadequate in its consideration of socio-economic and human health effects. Further technical issues concerning the operating rules, water levels, and compensation were also raised.

The CBO believed it was heard and its issues at least partially addressed by the International Joint Commission, and in this regard there was a match between its intentions and the outcomes of its actions. However, the CBO believed it was not heard and its issues were not addressed during the KGS and government-led processes. These mismatches between intention and outcome did not result in double-loop learning, but they did cause the organization to sharpen its recent adversarial turn in its tactical and strategic public

maps. Additionally, as with the other initiatives, the CBO's participation resulted in substantial changes to the aspects of its organizational memory that encoded knowledge of flooding, hydrology, engineering, administrative procedures and flood management options. It also resulted in changes to personal and organizational relationships: "Initially we were of the view that our concerns were very much different than the issues of [organization ABC]. As we came to understand some of their issues, it became clear that we're probably wrong in our initial assessment; these guys really did share much of our concerns" (Participant 3).

4.8. Floodway expansion environmental assessment

After the provincial government opted for the floodway expansion, the Floodway Management Authority, the project proponent, applied for approvals to proceed. The approval process involved a federal-provincial impact assessment, which included several opportunities for public involvement, e.g., open houses, workshops, and public hearings. The proponent also held its own consultations, which dealt with issues that had been ruled outside the purview of the impact assessment, including flood compensation and aspects of the floodway's operating rules.

In June 2005, the provincial assessment was completed and it recommended that a conditional license be granted for the expanded floodway. Among the issues dealt with in the conditions was the floodway's operating rules (Manitoba Clean Environment Commission 2005). A federal assessment of the project was also done, and concluded that the project was not likely to result in significant adverse effects (Hayward et al. 2007). In July 2005, the Manitoba government issued a license, and construction began shortly thereafter. The expanded floodway, offering protection from 1-in-700 year floods, became operational in 2009 and was completed in 2014 (Manitoba Floodway Authority 2014).

Although skeptical of the legitimacy of the impact assessment, the CBO engaged in the process in various ways (sources: access to information records, correspondence, meeting minutes, participant funding records, technical studies, written testimony). It provided written comments on assessment documents, participated in a stakeholder workshop, wrote to government officials, and met privately with the project proponent. It also assembled a team of expert advisors, applied successfully for participant funding, and participated in public hearings. The organization also commented on the final assessment reports, and supported a motion by another stakeholder group for a judicial review of the federal approvals. Throughout the assessment, the CBO reiterated its longstanding concerns, commented on technical matters pertaining to the expansion, and criticized the assessment itself.

The CBO was unsuccessful in having its major concerns addressed during the floodway assessment, and in this regard there was a mismatch between its intentions and the outcomes of its actions. Documents manifesting its organizational memory do not reveal double-loop learning, but they do show reinforcement of the single-loop adjustment adopted in the operating rules review, e.g., a willingness to take a more adversarial approach. "When intervener funding was announced, some of the enthusiastic community members thought there was a more aggressive way of tackling this problem" (Participant 4). The documents also indicate a reinforcement of the CBO's foundational values and beliefs coupled with mounting mistrust of the provincial government and a growing concern that its claims would never be resolved. Finally, once again, participation enabled the CBO to

deepen its knowledge of flooding, hydrology, engineering, and legal procedures, and its connectedness with other risk flood risk management stakeholders.

5. Discussion and conclusions

The CBO's foundational values, goals and beliefs were established in the wake of a flood disaster. The organization was, therefore, highly motivated and unwavering in pursuit of its goals and defence of its values and beliefs. It is not surprising then that the CBO's involvement in the five management initiatives discussed above did not result in double-loop experiences that transformed its fundamental governing variables. It did, however, experience single-loop learning in pursuit of its goals and objectives. It enhanced its connections with people and organizations having mutual interests, and it broadened and deepened its technical knowledge of geography, hydrology, engineering, politics and law. Further, it moved easily from its original administrative and management oriented strategy to one that included more adversarial tactics, including pursuing legal remedies.

These single-loop experiences suggest that individual or social learning occurred in the CBO (see Table 1), and that the CBO's organizational frame, its members' social-cognitive filters, and its internal facilitated platforms (see Table 2) enabled the resultant learning outcomes to become embedded within and withdrawn from organizational memory (Argyris and Schön 1978, Argyris 1993). They also demonstrate that the public involvement processes used in the five management initiatives provided good opportunities for instrumental, technical learning, consistent with Fitzpatrick (2006), Hayward et al. (2007) and others. These involvement processes, which can be conceived of as facilitated platforms (Maarleveld and Dangbégnon 1999), were typical of those found in state-driven natural resource planning and management in Canada; they were not highly participatory, but neither were they mere public relations exercises (Haque et al. 2002, Sinclair et al. 2003, Diduck et al. 2015). It remains to be seen whether highly participatory facilitated platforms, involving dialogue, deliberation and attention to resolving value and normative conflict, would have triggered a double-loop experience for the CBO. This is not a given because of the extent to which the CBO's fundamental governing variables were forged in opposition to the flood risk management initiatives that were undertaken.

A related issue is the degree to which highly participatory platforms might have precipitated double-loop network learning. Such learning is vital for broad dispersion of innovative knowledge, values and outlooks (Knight and Pye 2004, 2005), which could help further align flood risk management along sustainable trajectories. Similarly, a salient question is the extent to which participatory platforms would have driven change in the fundamental governing variables of government flood management agencies. Again, this is not a given because of the prevalence of power asymmetries in participatory platforms, especially in relationships between government agencies and community-based stakeholders (Muro and Jeffrey 2008, Raik et al. 2008). However, if such change involved institutional reforms, or societal learning (Table 2), these would have far-reaching and long lasting implications (Woodhill 2002, Waddell 2005). Moreover, if the reforms enabled community-based social marketing about flood risks and the development of adaptive co-management approaches to flood management (Table 2), the implications could include socio-political empowerment among flood management stakeholders (Armitage et al. 2009, McKenzie-Mohr and Smith 1999). Such an outcome would serve social objectives of sustainability, such as increased equity in civic engagement (Goodland and Daly 1995).

The conceptual framework and case study results show promise for analyzing and enhancing flood risk management theory and practice, particularly understanding and promoting adaptive learning, transformative change, and social objectives of sustainability, such as participation, empowerment and equity. However, the framework is highly abstract and the case study results are tentative due to the retrospective research design. Moreover, the case emphasizes just one aspect of the overall framework, namely organizational learning. Further research is clearly needed to empirically test more of the framework's elements and interconnections using various qualitative and quantitative strategies of inquiry and methods. For example, there is a need to unpack organizational learning by analyzing the interplay of social-cognitive filters pertaining to flood risk, the design features of facilitated platforms for social learning, and stakeholders' organizational frames. As well, although research on adaptive co-management has proliferated in recent years, its enabling institutional arrangements in flood risk management require further investigation. Third, dialogical and deliberative forms of communication in risk management are increasingly prevalent (e.g., Renn 2009), and the lessons they offer could be highly instructive for facilitated platforms and community-based social marketing in flood risk management. These are just some of the promising opportunities for research into adaptive, multi-level learning in flood risk management, and my hope is that they and this paper as a whole spur further interest in this topic.

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